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(54) Maltose and maltitol syrups and their preparation.

(57) The invention relates to high maltose syrup containing from 60 to 80% maltose, from 12 to 24% glucose and from 8 to 16% sugars having a DP of three or more; the preparation of such syrups by the enzymatic saccharification of partially hydrolyzed starch having a dextrose equivalence of from 1 to about 30; and the maltitol blends containing from 60 to 80% maltitol, and from 12 to 24% sorbitol, the latter blends having a desired combination of high sweetness and humectancy.

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MALTOSE AND MALTITOL SYRUPS
AND THEIR PREPARATION

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Background of the Invention

It has long been desired to produce bulk sweeteners having a combination of sweetness, high humectancy, non-cariogenicity, low calorie content and safety for diabetics. Such sweeteners are useful in the manufacture of diabetic and dietetic foods and candies, non-cariogenic chewing gum, animal foods, toothpaste, tooth-protecting products and pharmaceuticals.

Although several sweeteners are available which meet some of the above requirements, none of them has all the desired characteristics and all have certain deficiencies. For example, fructose, although it has intense sweetness, also has high calorie content, cariogenicity and low humectancy. Xylitol, although it has all of the desired properties, is not acceptable because animal tests indicated the possibility of bladder tumors.

One type of material which meets most of the above requirements is conventional maltitol syrups. These are prepared by the hydrogenation of conventional high maltose syrups which generally contain over 60% maltose and a minimum of dextrose. However, the use of conventional maltose syrups for producing sweeteners is not always effective because their low dextrose content (generally less than 10% and most commonly less than 5%) gives hydrogenation products low in sorbitol, the component which has high humectancy and sweetness. Thus, to improve the humectancy and sweetness of these products, they have to be further formulated with the addition of sorbitol.

The preparation of conventional high maltose syrups is described in the prior art. For example, U.S. Patents 3,795,584 and 3,804,715 assigned to Hayashibara show the saccharification of liquified starch to produce high maltose solutions using beta-amylase and alpha-1,6-glucosidase (pullulanase). However, such sugar compositions contain a maximum of a few percent of glucose.

CPC International U.S. Patent No. 3,565,765 also shows the formation of high maltose syrups using a combination of enzymes. This patent shows the simultaneous use of a maltogenic enzyme and pullulanase to form high maltose syrups. While higher glucose
5 levels than the Hayashibara patents are reported, the maximum amounts shown are less than 10%, generally less than 5%, and the sugars having a degree of polymerization of three or more are most frequently over 10%.

Another patent showing the enzymatic conversion is the A.E.
10 Staley U.S. Patent 3,791,865. It shows the use of a mixture of beta-amylase and amylo-1,6-glucosidase to form high maltose syrups having small, even trace, amounts of dextrose and having maltotriose contents of greater than 18%. CPC International's U.S. Patent 3,549,496 shows the conversion of partially hydrolyzed starch into
15 compositions containing maltose and up to 45% of dextrose using Bacillus polymyxa amylase in a first conversion followed by glucoamylase. Such products have comparatively low maltose concentrations and high concentrations of saccharides having a degree of polymerization of three or more.

20 Other patents which show the production of high maltose compositions include Hayashibara U.S. Patents 3,832,285 and 4,032,403; AB Stadex U.S. Patent No. 3,996,107; Meiji Seika Kaisha U.S. Patent 3,998,696; and CPC International U.S. Patent 4,113,509.

25 Brief Description of the Invention

This invention relates to a high maltose syrup containing from 60 to 80% maltose, from 12 to 24% glucose and from 8 to 16% saccharides having a degree of polymerization (DP) of three or more. In addition, the invention relates to a method of preparing such
30 high maltose syrups by the enzymatic saccharification of partially hydrolyzed starch having a dextrose equivalence (DE) from 1 to 30, preferably from 5 to 30, in the presence of three enzymes, namely, beta-amylase; alpha-1,6-glucosidase; and fungal alpha-amylase.

A further embodiment of this invention is the product obtained
35 from the hydrogenation of the aforementioned high maltose blend. These hydrogenation products contain from 60 to 80% maltitol, from

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12 to 24% sorbitol, and from 8 to 16% maltotriitol and other hydrogenated products having a DP of three or more.

The latter compounds are particularly useful for the preparation of products where high sweetness and humectancy are desired.

5 Examples of such applications are: chewing gums, soft candies, jams and jellies, animal foods, tooth-paste, and a great variety of diabetic and dietetic foods.

10 An additional advantage of having less than 16% of the hydrogenated products having a DP of three or more is the lower viscosity and processability of this type of sorbitol/maltitol product relative to other maltitol products containing 60-80% maltitol.

Detailed Description of the Invention

15 The high maltose product of this invention is prepared from a partially hydrolyzed starch having a dextrose equivalence from 1 to 30, preferably from about 5 to 30. The formation of such partially hydrolyzed starches is well known and they may be commercially prepared by heating the starch with hydrochloric or sulfuric acid at a high temperature and then neutralizing the hydrolysis mixture with sodium carbonate, or, alternatively, by an enzymatic process, 20 also performed at a high temperature, using alpha-amylase as the enzyme. This enzyme effectively hydrolyzes the starch by cleaving one molecule of dextrose at a time from the starch molecule. These "thinning steps" are described in the abovementioned U.S. Patent 4,113,509.

25 Examples of "partially hydrolyzed starch" which may be used in the preparation of the high maltose syrup of the invention include maltodextrin and waxy maize syrup having a DE of 4 to 20, liquid starch having a DE of 1 to 2, and low conversion corn syrup having a DE of 20 to 30. Such products are well known to those 30 skilled in the art.

In the process of this invention, the partially hydrolyzed starch is further saccharified in the presence of three enzymes, namely, beta-amylase, alpha-1,6-glucosidase (as, for example, pullulanase), and fungal alpha-amylase. The first two of these 35 materials are readily available from EDC Corporation, BIOCON, and Fermco Biochemics Inc., and the third, known commercially as

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Fungamyl 800L, from Novo Corporation. The reaction may be readily carried out by employing about equal quantities of the beta-amylase and the alpha-1,6-glucosidase and at least 10% of the fungal alpha-amylase. Generally speaking, from 30 to 50% of each
5 of the first two enzymes is used and from 10 to 40% of the third.

The reaction is best carried out in an aqueous medium containing less than 45% solids, most preferably from 25 to 35%, while the pH of the solution is maintained in the range of 4.5 to 6, preferably from 5.0 to 5.5. The reaction temperature is generally
10 from 40 to 60°C, preferably from 45 to 55°C, and the reaction time from 36 to 144 hours. Based on solids, the total enzymes used are at least 0.1%, but not more than 1%; preferably from 0.3 to 0.5% of total enzymes are used.

By following the aforementioned process of the invention, a
15 high maltose syrup is obtained containing from 60 to 80% maltose, from 12 to 24% glucose, and from 8 to 16% saccharides having a DP of three or more. Such products are useful in candy compositions, dessert formulations, and, because of their high fermentable contents, for the baking and brewing industries. In addition, such
20 compounds may be readily hydrogenated to form high sorbitol-maltitol mixtures by following well-known hydrogenation techniques. The hydrogenation of the high maltose syrups of the invention may be performed over a Raney nickel catalyst by contacting the high maltose syrups under pressure with hydrogen. The pH is generally
25 maintained at from about 4.5 to less than 7. The following patents show the conventional technique for hydrogenation, the subject matter of which is incorporated by reference herein: U.S. Patent 3,705,039, Hayashibara; U.S. Patent 4,279,931, Roquette Freres; and U.S. Patent 3,708,396, Hayashibara.

30 The products of the hydrogenation have a ratio of hydrogenated products which correspond substantially to the saccharides from which they are derived. It is common, however, depending on the conditions of the hydrogenation, for there to be some variation in the content of the corresponding hydrogenated products. Such
35 alterations will be readily understood by those skilled in the art. Accordingly, the sorbitol/maltitol composition of the invention contains from 12 to 24% sorbitol, from 60 to 80% maltitol, and from 8 to

16% hydrogenated products having a DP of three or more. Such products are useful as sweeteners because of the high concentration of sorbitol in combination with the maltitol. Additionally, these latter products have greater humectancy than the prior art high maltitol compounds. This is particularly useful in the following applications: diabetic and dietetic foods, animal foods, candies, non-cariogenic chewing gum, toothpastes and mouthwashes.

In order to more clearly illustrate this invention, attention is directed to the following examples.

10 Example 1

A waxy maize syrup (Maltodex 3260, trademark of A.E. Staley) containing 70% solids was diluted to 35% solids by adding 150 g of water to 150 g of the waxy maize syrup. The waxy maize syrup had a DE of 20. The solution was brought to a pH of 5.4 by the addition of a drop of 50% NaOH. The solution was placed in a 500 ml Erlenmeyer flask and 0.16 g of alpha-1,6-glucosidase (pullulanase), 0.16 g of beta-amylase, and 0.16 g of Fungamyl-L (trademark of Novo Corporation for alpha-fungal amylase.) The flask was thereafter capped and placed in a shaker water bath maintained at a temperature of 50°C. The flask was shaken at this temperature for 64 hours. The solution was then filtered to remove residual enzymes and analyzed by H.P. liquid chromatography to determine carbohydrate distribution. The analysis showed that the solution contained 14.3% dextrose, 70.9% maltose, and 14.8% saccharides having a DP of three or more.

Example 2

A low conversion corn syrup having a DE of 26 (Staley 200) was diluted to 35% solids. To 300 g of this diluted syrup in a 500 ml Erlenmeyer flask were added 0.21 g of beta-amylase, 0.21 g of alpha-1,6-glucosidase and 0.09 g of Fungamyl L enzymes. The solution had a pH of 5.1. The flask was thereafter capped and placed in a shaker water bath maintained at a temperature of 45°C. After reacting for 89 hours, the product contained 17.8% dextrose, 71.8% maltose and 10.5% saccharides having a DP of three or more.

Example 3

This example shows the preparation of the sorbitol/maltitol composition of the invention. A high maltose syrup obtained by the procedure described in Example 2 but reacted only for 64 hours has
5 the composition of 16% dextrose, 70% maltose and 14% of saccharides having a DP of three or more. This syrup is hydrogenated using conventional techniques at 1000 psi of hydrogen at 135°C in the presence of a Raney nickel catalyst for 5.5 hours.

The hydrogenation product is analyzed and found to contain
10 21% sorbitol, 64% maltitol and 15% hydrogenated compounds having a DP of three or more. Such product is ideally suitable as a humectant and/or sweetener in diabetic and dietetic foods, animal foods, non-cariogenic chewing gum and candies, toothpastes and mouth-washes.

CLAIMS:

1. A polysaccharide composition characterised in that it contains from 60 to 80% maltose, from 12 to 24% glucose, and from 8 to 16% saccharides having a DP of three 5 or more.

2. A process for preparing a polysaccharide composition characterised in that the process comprises contacting under saccharification conditions a partially hydrolyzed starch having a DE of from 1 to 30 with a 10 3-component enzyme composition including beta-amylase, alpha-1,6-glucosidase, and fungal alpha-amylase, thereby obtaining a product high in maltose and containing from 12 to 24% glucose and from 8 to 16% saccharides having a DP of three or more.

15 3. A process according to claim 2 characterised in that the partially hydrolyzed starch is a maltodextrin, a waxy maize syrup, or a low conversion corn syrup.

4. A process according to claim 2 or claim 3 characterised in that the saccharification takes place in 20 an aqueous solution containing less than 45% of solids at a pH of from 4.5 to 6, at a temperature of from 45 to 60°C, and a reaction time of from 36 to 144 hours.

5. A composition having high sweetening properties and humectancy characterised in that it comprises from 12 25 to 24% sorbitol, from 60 to 80% maltitol, and from 8 to 16% saccharides having a DP of three or more.

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Maltose and maltitol syrups and their preparation.

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The invention relates to high maltose syrup containing from 60 to 80% maltose, from 12 to 24% glucose and from 8 to 16% sugars having a DP of three or more; the preparation of such syrups by the enzymatic saccharification of partially hydrolyzed starch having a dextrose equivalence of from 1 to about 30; and the maltitol blends containing from 60 to 80% maltitol, and from 12 to 24% sorbitol, the latter blends having a desired combination of high sweetness and humectancy.

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EUROPEAN SEARCH REPORT

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EP 85 30 5381

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A-2 012 767 (CPC INTERNATIONAL) * Tables I,II *	1-4	C 13 K 7/00 C 07 H 15/04
X	BE-A- 633 645 (STALEY) * Claims *	1-4	
A	US-A-3 708 396 (MITSUHASHI et al.)		
X	EP-A-0 072 080 (ICI AMERICAS INC.) * Claims *	5	
A	CHEMICAL ABSTRACTS, vol. 89, 1978, page 453, abstract no. 58336t, Columbus, Ohio, US; T. YAMANOBE et al.: "Amylases from Bacillus effective for production of maltose. III. Effect of conditions in liquefaction of starch on production of maltose by beta-amylase and pullulanase of Bacillus cereus var. mycoides", & BISEIBUTSU KOGYO GIJUTSU KENKYUSHO KENKYU KOKOKU 1978, 50, 41-9		TECHNICAL FIELDS SEARCHED (Int. Cl.4) C 12 P C 13 K A 23 L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16-03-1987	Examiner LENSEN H.W.M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			